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A METHOD TO ADAPT THE WASHINGTON PRE-COLLEGE TESTING PROGRAM FOR USE IN A WASHINGTON JUNIOR COLLEGE.

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DESCRIPTORS- *JUNIOR COLLEGES, *COLLEGE ENTRANCE EXAMINATIONS, *PREDICTIVE ABILITY (TESTING), *GRADE PREDICTION, GRADE POINT AVERAGE, *COLLEGE FRESHMEN, VANCOUVER, WASHINGTON, WASHINGTON PRECOLLEGE TESTING PROGRAM,

TO DETERMINE THE POSSIBILITY OF IMPROVING THE EFFICIENCY OF PREDICTING FIRST QUARTER GRADE POINT AVERAGES FOR ENTERING FRESHMEN AT CLARK COLLEGE, REGRESSION ANALYSIS WAS USED TO ESTABLISH EQUATIONS FOR PREDICTING GRADE AVERAGES FROM SCORES EARNED IN THE WASHINGTON PRE-COLLEGE TESTING PROGRAM. PREVIOUS PREDICTION HAD BEEN BASED ON FORMULAS DERIVED FROM A STATEWIDE USE OF THE TESTING PROGRAM. EFFICIENCY OF PREDICTION FROM THE REGRESSION EQUATIONS WAS TESTED IN A VALIDATION STUDY, WHICH OBTAINED PREDICTIONS WHICH WERE (1) WITHIN THE EXPECTED RANGE OF ERROR FOR MATHEMATICS-SCIENCE-ENGINEERING MAJORS, (2) CONSIDERABLE IMPROVEMENT OVER EXPECTED ERROR FOR SOCIAL SCIENCE-HUMANITIES AND APPLIED ARTS MAJORS, (3) LOW IN EFFICIENCY FOR MAJORS IN BUSINESS AND SECRETARIAL SCIENCE, AND (4) SLIGHTLY LESS EFFICIENT THAN EXPECTED IN THE MID-RANGES OF UNDECIDED-LOWER DIVISION STUDENTS, THOUGH MORE EFFICIENT FOR THOSE MORE THAN ONE STANDARD ERROR ABOVE AND BELOW THE MEAN. THE STUDY ILLUSTRATED THE DANGERS IN APPLYING AT ONE INSTITUTION PREDICTIVE MEASURES DEVELOPED AT ANOTHER UNLESS THEIR VALIDITY HAS BEEN TESTED FOR THE SPECIFIC SITUATION. THIS DOCUMENT IS A PH.D. DISSERTATION, WRITTEN AT THE UNIVERSITY OF PORTLAND, OREGON. (WO)

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A METHOD TO ADAPT THE SUBSTITUTION PRE-COLLEGE TESTING PLAN FOR USE IN A JUNIOR COLLEGE

by

GAY ELSA MORGAN

A thesis submitted in partial fulfillment of the requirements for the degree of

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DEDICATION

The writer dedicates his entire program of doctoral study to his old friend, Professor Morris Gilbert Morgan, whose tragic death at sea, seven months before a doctoral program in marine biology at Stanford University and the Academy of Sciences in San Francisco was officially first [illegible] of "why?" with answers leading inescapably to a need for further inquiry on my part. His death cost the world a scholar. Such scholarship as has been achieved in my studies and any which may follow is a direct outgrowth of the example he set.

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A METHOD TO ADAPT THE WASHINGTON PRE-COLLEGE TESTING PROGRAM FOR USE IN A WASHINGTON JUNIOR COLLEGE

CHAPTER I

INTRODUCTION

The Washington Pre-College Testing Program was adopted at Clark College as an admission requirement for all new students entering in and after the academic year 1961-62. New students had to take the battery of tests supervised by the Washington Pre-College Testing Program and to file a transcript of high school grades.

Clark college is a tax-supported comprehensive community (junior) college drawing the bulk of its student body (1,914 for 1961-62; 1,598 for 1962-63; and 1,640 for 1963-64) from commuting distance. The large majority of students reside within Clark County, Washington, but commuting distance includes Portland, Oregon, from which 20-25 per cent of the student body is characteristically drawn. The two high schools contributing the greater number of students are both within the City of Vancouver, Washington.

The Washington Pre-College Testing Program was an outgrowth from research conducted by the University of Washington over a protracted period. Mills has given a full account of the history and rational of research conducted by the University of Washington. (2/) The research was designed to predict success for students on the basis

of pre-admission predictor variables. Test scores from the battery were combined with high school grades in a regression analysis to develop a set of regression equations. The basic criterion data were grades earned by students at the University of Washington. Separate regression equations yielded forty-eight predictions for each student; one prediction for the total cumulative GPA (grade-point average) called the all-college prediction, and one each for the GPA in forty-seven different subject areas of study that could be selected at the University of Washington. The study areas and scheme of predictions are shown in Figure 1, Appendix A. This prediction of potential success for different subject areas was referred to as differential prediction. The predictions are for any number of quarters of study.

In 1959, Horst and associates published research to support the selection of specific predictor variables included in each of the forty-eight regression equations. (24) The need for and the advantages of a state-wide program of pre-college counseling using differential predictions was put forth by Horst. (25)

A state-wide program was implemented under the name of the Washington Pre-College Testing Program, encompassing test supervision, calculating predictions and distributing them to all schools having adopted the program. At the time Clark College joined the system in 1961, there were over twenty public and private Washington universities, colleges and junior colleges using the Washington Pre-College Testing Program.

I. THE PROBLEM

Seashore noted that as junior colleges have unique educational roles to perform, they need to validate tests against their own unique criteria. (19:80) He also noted that junior college freshmen generally do not score as well on the CQT (College Qualifications Test) as do four-year college freshmen.(19:75) The Encyclopedia of Educational Research stated that it is not possible to adopt the prediction formulas of others without verification in any particular situation. (21:1039) The predictions of the Washington Pre-College Testing Program were applied to students entering Clark College without verification. A validity study was needed.

Due to considerable differences in the organization of the University of Washington and Clark College, no prediction other than the all-college prediction could be used for the applied arts programs at Clark College. Similarly, there was no prediction for an undecided major pursuing a general course of studies in the lower division program. The differential predictions reflected the organization of the University of Washington and not that of Clark College. Hence the only test of efficiency possible was to check the efficiency of the all-college prediction of the Washington Pre-College Testing Program.

A pilot study was made of the efficiency of the all-college prediction for 616 first experience freshmen entering Clark College in the Fall Quarter of 1961-62. It was found that the mean all-college prediction of the Washington Pre-College Testing Program was 1.62. The achieved mean GPA for the first quarter of course work at Clark College

for the same group was 2.04. A "t" test showed that the mean difference between predicted and achieved GPA was significant at less than .01 level of confidence. Hence, the all-college prediction was significantly lower on the average than earned first quarter grades, and the difference could not be attributed to chance.

Statement of the problem. As the pilot study showed that the all-college predictions of the Washington Pre-College Testing Program apparently were not directly applicable to Clark College, the problem was to determine if the predictions could be improved by modification and addition of locally established variables. If this was possible, similar approaches would be applicable to all junior colleges in Washington.

Hypothesis. By use of a regression design, a set of variables, one being the all-college prediction, can be tied to establish a set of valid regression equations to predict success in study areas offered by Clark College.

Method. The study was a normative-survey divided into two parts: (1) developing regression equations, and (2) validation.

For the first part, all entering first experience freshmen at Clark College in the Fall Quarter of 1961-62 and 1962-63 were used, giving a sample of 1,213 cases. The validation sample was composed of 563 freshmen entering Clark College in the Fall of 1963-64.

Criterion variable. The basic criterion variable was first quarter GPA at Clark College. (Clark College grades on a five-point scale: A = 4, B = 3, C = 2, D = 1, and F = 0) This was at variance with the all-college prediction based on the assumption that a constant

level of success persisted for a student no matter how many quarters he attended. As suggested by Fricke, the data available prior to admission to college should be used for predicting success in the first experience. The first quarter GPA then becomes the best predictor for second quarter success and so on. (10) Semenizieo showed that only a small percentage of students getting on probation in the first semester tend to graduate. (29) Thus the first college experience of a student is of paramount importance to him. To have a predictor for this period is a vital tool in admissions and guidance. Further, if predictions for the two years at a junior college were desired only those students who completed two years of study should be used to establish forecasts. Tugman discovered that the GPA is not constant for successive semesters for any one student. (30) Thus to assume that a student leaving college, for example, at the end of the first quarter would have the same GPA at the end of two years as at the end of the first quarter (or conversely) is indefensible. Some of the unreliability of the all-college prediction is likely due to the faulty assumption of constancy of the GPA.

In order to establish homogeneity, the total samples, prediction and validation, were categorized into five areas:

1. mathematics-science:
   self-declared majors in mathematics, physical sciences, life sciences (including biology, home economics, agriculture and registered nursing students), general science, and all engineering fields
2. social sciences-humanities:
   self-declared majors in art, English literature, foreign

language and literature, music, philosophy, speech, anthropology, economics, geography, history, political science, psychology, sociology, and all education majors

3. undecided-lower division:
students taking lower-division course work with declared majors as general, liberal arts, none, undecided, or neglected to fill out the blank calling for a declaration of a major (The Clark College curriculum does not permit a student to be an undecided applied arts major as each of these programs requires two full years of associated laboratory work which forces the student to make a first quarter choice of a major.)
4. applied arts:
self-declared majors in all but one of the terminal or applied science programs (These programs are not designed for students transferring to degree granting schools but are designed to give entry skills into various technologies, trades and skills. The program not included was practical nursing as this is a one year program and as the students spend most of their time in hospitals and not on campus.)
5. business-secretarial science:
self-declared majors in any field of specialty of business (excluding business education) and secretarial-clerical programs (again excluding education majors)

Predictor variables. These were:

1. All-college prediction of each student as calculated by the

Washington Pre-College Testing Program and sent directly to the college using the prediction program as a guidance tool

2. Clark College hours of credit completed for the first quarter of study (The sum of credit awarded those courses for which the student was given a grade, including the grade of "F".)

3. Residence with resident referring to students from a Washington high school and non-residence referring to all other entering students (Residence was coded "1" and non-residence "0".)

4. High school mathematics honor points (The sum of all mathematics course work converted to numbers after the system of A = 4, B = 3, C = 2, D = 1, F = 0. These were summed on the basis of semester grades and not yearly grades.)

5. Number of semesters of solids in high school (A count was made of the number of semesters of course work the student completed from the following list of high school subjects: English; foreign language, including Latin; mathematics, excluding general, senior, and consumer mathematics; and science, excluding first year biology, general and physical science.)

A multi-correlation analysis was used for establishing regression equations to calculate predictions for Clark College first quarter GPA for each study area. The Air Force method of calculating inter-

correlations of predictor and criterion variables was used as outlined by Tugman. (30) A maximum prediction battery was determined through the Horst iterative process. (14) The Abbreviated Doolittle Method was used for calculating regression weights for the selected predictor variables as outlined by Wert, Neidt, and Ahmann. (3)

Validation design. The actual and predicted GPAs for the validation sample were compared in terms of the standard error of the prediction.

Limitations of the study. The findings were applicable only to Clark College. Only the method was to be generalized for other junior colleges.

It was postulated that any entering class at Clark College is a representative sample of the parameter of Clark College students.

Students excluded from the study were those who: (1) entered Clark College or any other college or university for the summer session immediately preceeding entrance in the Fall Quarter as freshmen; (2) enrolled previously at any other institution prior to entering Clark College and subsequently withdrew (this excluded students previously enrolled at Clark College for any period who dropped and then re-entered); (3) entered to satisfy high school graduation requirement; (4) withdrew before receiving grades other than "W"; (5) enrolled only for night or other adult program course work; (6) enrolled as part-time students (fewer than eight credit hours); and (7) enrolled in the LPN (Licensed Practical Nursing) program. Predictions were not possible for any of these categories of students on the basis of this study.

II. DEFINITION OF TERMS

GPA is an abbreviation for grade-point average. It is computed by dividing the honor points earned by the hours of study carried.

Junior college. This term was used in preference to but as synonymous with community college as the term junior college tends to be more widely understood. It should be noted that the term junior college as used in this study includes those schools offering technical-industrial-vocational-trade training and study in conjunction with lower division study. It was not restricted to those institutions offering but the first two years of a degree program.

III. ORGANIZATION OF THE STUDY

Chapter II gives a review of pertinent literature. The selection of study groups and methods of data collection is indicated in Chapter III. The presentation and interpretation of data and results are made in Chapter IV. Chapter V gives the summary of the study, followed by a bibliography and two appendices.

CHAPTER II

REVIEW OF PERTINENT LITERATURE

An extensive literature was found relative to the prediction of college success. Bloom and Peters stated:

> The problem of predicting college success has probably received more public attention than any other single problem in education. The amount of effort, thought, time and money that has poured into attempts to improve academic prediction has been very great. Thousands of studies have been published, and these represent but a small fraction of those that have been made. (1:6).

They presented also an historical overview of philosophy, methods, and findings and a recent point of reference. Most of the studies were done in four-year colleges or universities. Relatively little has been devoted to predicting success at the junior college.

I. JUNIOR COLLEGE STUDIES

Reviews. Several extensive reviews and digests of junior college research were consulted. Five were of particular value. Adams reviewed the contents of the Junior College Journal for the twenty-six year period of 1930-1956. (4) Morrison and Martorana extended this review and included other sources, though they noted the great bulk of research relative to the junior college was found in the Junior College Journal. (20) Mills presented a comprehensive bibliography of junior college studies to a state-wide research seminar on junior college problems held at Olympia, Washington, in 1963. (26) Parker assembled a bibliography of doctoral dissertations concerned with the junior college. (18) Parker's

list was supplemented by Eells who pointed out that the first dissertation to deal comprehensively with the junior college movement was written by F. M. McDowell at the State University of Iowa in 1918. (9:16)

Adams categorized the studies found in the Junior College Journal. One such category, representing 2.5 per cent of the total published, was the Use of Tests. In this was included inventories, check lists, discussion of need, surveys, and prediction of student success. (4:213) The number of studies devoted to each of the sub-categories was not given. He concluded that, "There is a general need for real rather than literary evaluation." (4:216).

From these five studies and a general review, it was evident that the writers in the junior college field have contributed little to the available literature on prediction studies of college success. Where they have been concerned, the junior college administrations have been, generally speaking, adapters of existing prediction studies originating from the four-year colleges or universities. These predictions developed elsewhere have been used in the junior college with little or no reference to the unique structure and function of the junior college. Apparently little attention was given to the cautions of Seashore, (19), and others, (21), that this was not advisable without checking the predictions against locally derived data. Five studies were found, however, dealing with some aspect of prediction of success relative to the junior college.

Transfer studies. Boston University Junior College was designed principally to prepare the low academic ability student for entrance into Boston University. LaFauci and Richter reported a study geared to

identify and select the four year student from the junior college students. A board was created which, in effect, made predictions of potential four year school performance based on test scores, interviews, and actual performance in the junior college for at least one semester of work as measured by grades. Figures were cited of the number of students who had successfully made the transfer to Boston University, but these were not concerned with relative success as measured by grades nor with differential prediction relative to potential performance in each of several different possible majors. (15)

Calia reported another Boston Junior College study where he had attempted to use discriminant analysis in the prediction of "success" or "attrition" after the junior college student had transferred to Boston University. He employed a total of thirty-three variables as predictors with the study group of the 1957 entering freshman and with findings validated against the 1956 entering freshmen. Though the predictions generated proved inconclusive, Calia concluded that,

> It would appear that the student who has verbal reasoning aptitude and creative interests (literary and scientific), frequently sought help from teachers, and gave promise of achievement during first semester was most likely to attain transfer status by the end of his freshman year. (5:138)

Junior college predictions. Tracy reported a study in 1953 in which predictions were made from regression equations developed for junior college pre-professional business majors and secretarial science majors. Four equations were developed for the pre-professional business major; two for the total junior college experience, one for first semester grades, and one for major program grades. For secretarial science majors a separate equation was made for prediction of the total

college experience. Based on 126 cases drawn from Los Angeles County community colleges, he developed a multiple correlation of .630 for business majors for the cumulative junior college experience by using five variables. These were I.Q. scores, high school rank, grades in high school English, grades in high school algebra, and the composite score from the Iowa Tests of Educational Development. For secretarial science a multiple correlation of .699 was achieved for the criterion of all college experience with two variables, high school English grades and the composite Iowa Tests of Educational Development scores. The highest zero order correlation calculated was .537 between all college grades and high school English grades. No standard error of estimates were presented for any of the five equations, but the study reported a 2:3 chance existed that grades for a secretarial science major would be within 0.62 and 1.54 under certain circumstances. It was assumed that the standard error of estimate for at least this regression equation was half the difference of the two figures cited. No validation of the five equations was reported. Though criticism for lack of validation evidence can be made, Tracy's study was most noteworthy as it reported attempted prediction specifically for the junior college experience, for first semester experiences as a separate criterion and for majors or specific programs of study. (20)

In 1962, Dorian analyzed attrition rates in the registered nursing program of certain California community colleges. With 366 students of nursing who began studies in 1958 at eleven different California community or junior colleges, Dorian developed absolute predictions for "success" or "failure." His treatment of data centered on the development

of a cutting score as a non-linear approach to what would be a linear coefficient of determination. The cutting score yielded absolute prediction; i.e. above a certain critical score success was predicted. No attempt was made to predict for specific GPA nor for any period of study such as one quarter or one year. Berian recommended further study and suggested that because of the high rate of attrition found during the first year, the first year should be used as the criterion of success for future study. Berian also made the observation that the most efficient prediction would be obtained when a single college develops adequate actuarial data on its own students over a period of years. (1)

Another regression analysis of junior college experience for prediction was reported by Gustafson. His study was essentially a check of the relationship between scholastic aptitude scores and achievement of freshmen during the first semester at Sheridan College, a two year school in Wyoming. The study group was 169 entering freshmen for Fall, 1959. The group was divided on the basis of sex into two samples. Two regression equations were calculated. No standard error of estimates for the predictions were presented. No validation was reported. No indication of the efficiency of predictions was given. However the study was noteworthy in that it attempted to predict for the junior college experience and exclusively for the earned GPA of the first marking period. Gustafson concluded in part:

> Due to differences in faculty, type of students, curriculum of the institution, grading practices, sources of students and for many other reasons, it can not be expected that the relationship between SCAT T, M.S.C.P.A.'s and grades earned would be the same as that found at Sheridan College. It can be expected, however, that the general findings of this study would apply to other junior

colleges although research must be conducted in those institutions to determine the exact relationships . . . (13:140)

II. WASHINGTON PRE-COLLEGE TESTING PROGRAM

Development. The history of research and statistical methods which led to the Washington Pre-College Testing Program's predictions was reported by Mills. (27) Data leading to the inclusion of various factors to be used for each of the differential predictions and for the all-college prediction was presented by Horst and associates. (24) Blumenthal reported in 1961 on research relative to the efficiency of the predictions as measured by standard errors of estimate. (22) Horst presented the argument for adoption of a state-wide testing program in preference to the national programs of The American College Testing Program, The College Entrance Examination Board Tests, and the Psychological Corporation tests. (25)

Validation. As related to the junior colleges which have adopted the testing program predictions, it was known at writing time for this study that two validation studies were in progress though incomplete. These studies by colleagues at Centralia College, Centralia, Washington, and Grays Harbor College, Aberdeen, Washington, were concerned with the efficiency of predictions as they related to students beginning college at a junior college and then transferring to either the University of Washington or Washington State University. The criterion was to be experience at the four year institutions.

One study related the variables employed by the Washington Pre-College Testing Program to junior college first quarter earned GPA.

In an unpublished thesis dated 1964, Watenpaugh reported a study made on freshmen enrolling at Big Bend College, Moses Lake, Washington. His study group was freshmen entering Fall Quarters of 1962 and 1963. The group totalled 130 students. Watenpaugh was concerned with, among other things, the calculation of a regression equation with first quarter earned GPA as criterion and using the predictor variables of tests and high school GPA as used by the Washington Pre-College Testing Program. He was also concerned with the difference between students entering from small high schools versus those from large high schools, and he calculated two regression equations based on this classification and another for the total group. There were twenty-seven cases for the small high school equation and 129 for the large high school equation. His conclusions were confined to an analysis of coefficients of correlation and not with the efficiency of the predictions rising from the regression equations. No validation study was reported. His study was important, however, in that it attempted to predict for the junior college experience, for the first marking period, and as it made a distinction in the study group and classified it into two samples in order to achieve greater homogeneity. Further the regression equations calculated were based on tests scores and high school GPA weighed against local experience. The study was, however, severely limited by the size of the study group and by the lack of validation of the regression equations developed. (31)

III. CONCLUSION

Whereas the literature on predicting college success is

extensive, the concern with success at the junior college is extremely limited and inadequate. Further the use of the Washington Pre-College Program for Washington junior colleges without sound validation indicates the great need for the present study.

CHAPTER III

SELECTION OF STUDY GROUPS AND METHODS OF DATA COLLECTION

I. THE PILOT STUDY

Following the adoption of the Washington Pre-College Testing Program effective for Fall Quarter, 1961, the question was raised at Clark College if the predictions forthcoming could be applied directly to the local experience. That is, could the predictions based on student experience at the University of Washington be applied to potential student experience at Clark College without modification? If so, with what degree of confidence could they be used?

From the Washington Pre-College Testing Program, forty-seven differential predictions and one prediction for total college experience called all-college prediction were received at Clark College for all students entering college for the first time Fall Quarter, 1961. The differential predictions were for coursework in specified areas of study such as zoology. The all-college prediction was for an unspecified number of quarters or terms of study. No prediction was included for any specified period such as one quarter, one year or for the two years typical for Clark College.

The all-college prediction was selected as a check on the efficiency of the Washington Pre-College Testing Program as this related to Clark College earned GPA for first college experience freshmen in their

first quarter of study. The reasons for selecting this marking period were presented in Chapter I.

The all-college prediction was chosen for use at Clark College as no other prediction for cumulative grades was available. Also in the case of many students, it was not always possible to use any of the differential predictions made for specific majors. For example, many entering students declared themselves as "undecided," though they signed for a liberal arts oriented program of studies. There was no prediction made by the Washington Pre-College Testing Program for the "undecided" major as no coursework labeled undecided existed for anyone to take. Additionally no differential prediction had been prepared by the Washington Pre-College Testing Program for anything comparable to the terminal areas of study at Clark College where students do not normally anticipate college work beyond the specific junior college program in which they are enrolled. It was determined then that the only prediction received which applied to any and all students was the all-college prediction. Hence it was chosen to be checked for its possible value as a single predictor for the Clark College first quarter experience. A prediction for this first marking period was needed.

The all-college prediction was checked for efficiency against first quarter earned GPA. The earned GPA used as a criterion was a cumulative figure; that is, it included all courses taken for which a grade was awarded, including failing grades but not including unsatisfactory or satisfactory withdrawal notations given in lieu of grades. Of necessity those students who withdrew from the college before grades were given were removed from the pilot study.

The test of efficiency of the all-college prediction was a "t" test of the significance of mean difference found between the mean all-college prediction and the mean first quarter earned GPA. Statistical procedures were taken from Wert and others. (3:99)

The group of students selected for study was all first college experience freshmen entering Clark College, Fall Quarter, 1961. By first college experience was meant first experience at any college, and transfer students new to Clark College but not to college work were excluded. Other special category students were excluded in conformance to exceptions and definitions presented in Chapter I. The final sample for the pilot study included 616 students.

The mean all-college prediction for the pilot study sample was 1.62. The mean first quarter earned GPA at Clark College for the sample was 2.04. The mean difference of .42 grade points was significant at less than the .01 level of confidence that the difference could not be attributed to chance. Hence the GPA predicted by the all-college prediction was significantly lower than earned GPA in the first marking period.

If the Washington Pre-College Testing Program were to be continued in use at Clark College, further work was indicated. It was decided that the all-college prediction should be included as a predictor variable in the further work done to improve the prediction for first quarter GPA at Clark College. A modification of the all-college prediction was needed by including other locally developed predictor variables in a regression analysis.

II. SAMPLE STUDIED

All entering freshmen for Fall Quarter, 1962, were added to the pilot study group where they met the same selection criteria. The total study sample now numbered 1,213 with complete data.

The GPA difference between means for predicted and achieved GPA as noted for the pilot study sample persisted with the addition of the 1962 entering freshmen to make the total sample studied. With a SD (standard deviation) of .595 for all-college prediction, .754 for earned first quarter GPA, an N (number of cases) of 1,213, and a mean difference of .260, the "t" value was 4.436 (where a "t" as large as 2.57 is significant at the .01 level of confidence). Hence the all-college prediction was predicting significantly lower than the earned first quarter GPA at Clark College at less than the .01 level of confidence. That the difference was due to chance was rejected for the total study group.

To achieve some homogeneity it was necessary to divide the total sample into five major areas of study relative to the Clark College curriculum. This was done as follows: (1) mathematics-science-engineering majors; (2) social science-humanities majors; (3) undecided program but in transfer or lower division work; (4) applied arts or terminal program majors; and (5) business and secretarial science majors. Programs of study included in each category were presented in Chapter I. Students were classified into one or the other of these five groups on the basis of their declared major. The total sample was now classified into five separate samples each giving a criterion variable of first

quarter earned GPA for regression analysis.

First a test was made to determine if the significant difference noted for the total sample between predicted and earned GPA persisted for each of the five samples. As shown in Table 1, four differences were significant at less than the .01 level and one at the .05 level. In all samples there was a significant under prediction of earned first quarter GPA by the all-college prediction. Therefore the all-college prediction could not be used with confidence for either the total sample nor for any of the five separate samples created from it.

III. THE VALIDATION SAMPLE

A validation sample was selected composed of all entering first experience freshmen for Fall Quarter, 1963. Complete data was available on 565 students. (See Table 2)

As shown in Table 2, four differences between predicted and achieved first quarter GPA were significant at less than the .01 level and one difference at the .05 level. In each case there was a significant underprediction. This suggested that the validation sample was comparable to the study sample.

IV. METHODS OF DATA COLLECTING

Additional data needed was taken from the high school transcript, the Washington Pre-College Prediction Program's counseling sheet sent to Clark College, and the student's registration form completed upon entering Clark College. (See Appendix A for samples of these forms)

The information needed was collected on simple data collecting

TABLE I

"t" TESTS FOR MEAN DIFFERENCES - ALL-COLLEGE PREDICTION AND ACHIEVED FIRST QUARTER GRADES FOR EACH MAJOR STUDY AREA

MAJOR[a]	MEAN GPA PREDICTED	MEAN GPA ACHIEVED	N	SD[b] GPA PREDICTED	SD[b] GPA ACHIEVED	"t"
1.	1.993	2.103	248	.489	.691	2.053*
2.	1.964	2.152	267	.533	.831	3.113**
3.	1.791	2.001	348	.521	.751	4.296**
4.	1.405	2.139	171	.387	.738	11.821**
5.	1.762	1.976	179	.463	.730	3.313**

a: where
1. math-science-engineering majors
2. social science-humanities majors
3. undecided lower division majors
4. applied arts or terminal majors
5. business-secretarial science majors

b. SD is standard deviation

* is significant at .05

** is significant at .01

TABLE 2

"t" TESTS FOR MEAN DIFFERENCES - ALL-COLLEGE PREDICTION AND ACHIEVED FIRST QUARTER GRADES FOR EACH OF FIVE VALIDATION SAMPLES

MAJOR[a]	MEAN GPA PREDICTED	MEAN GPA ACHIEVED	N	SD[b] GPA PREDICTED	SD[b] GPA ACHIEVED	"t"
1.	1.937	2.132	134	.480	.713	2.203*
2.	1.963	2.197	133	.503	.770	2.937**
3.	1.826	2.142	131	.439	.721	4.156**
4.	1.465	2.345	81	.383	.693	9.957**
5.	1.811	2.213	80	.451	.726	4.193**

a. where
1. math-science-engineering majors
2. social science-humanities majors
3. undecided lower division majors
4. applied arts or terminal majors
5. business-secretarial science majors

b. SD is standard deviation

* is significant at .05

** is significant at .01

sheets. It was then key punched into IBM cards and verified both by machine and by visual check following a "print out" where the information punched into the cards was reproduced in printing on sheets of paper.

The criterion variable for each of the five samples, earned first quarter GPA at Clark College, was recorded and key punched as three place numbers without a decimal; that is, a GPA of 2.55 was recorded as 255.

The first predictor variable used was the all-college prediction obtained from counseling sheets sent directly to Clark College by the Washington Pre-College Testing Program for each entering student. This data was presented as two place numbers without a decimal; that is, a prediction for 2.5 GPA was received as 25. (See Figure 1, Appendix A) The predictions were punched in cards as received.

The second predictor variable, number of credit hours completed during the first quarter, was taken directly from the student's college transcript. The number of hours completed included those where a failing grade had been received. This involved a grade by grade check to see if the registrar's office had entered on the transcript only those courses the student passed. (See Figure 2, Appendix A) As a rule, the number of hours completed was not different from the number of hours attempted or programmed upon entering. This data was recorded on the collecting sheets, punched into IBM cards without coding, and no subsequent decimal manipulation was necessary for interpretation.

The third predictor, student's legal residence, was taken from the student's registration form. (See Figure 3, Appendix A) The determination of student residence was not always an easy matter. The

decision of registration officials in this matter was final. A resident student was given the value "1" on the data collecting sheets, and the non-resident given a "0".

The fourth predictor variable, high school honor points earned in mathematics courses, required a search of each student's high school transcript. (See Figure 4, Appendix A, for a sample) All mathematics courses taken in high school were considered. Semester grades were converted to honor points as semester grades were common to most transcripts. Where but one grade was recorded for a course for an entire year of study, this grade was doubled. It was necessary that varying high school grading practices be converted to the same unit. The method used was adopted from a conversion sheet used for a similar purpose and developed by Ernest Hayes at the University of Portland. (See Table 3) The figure entered on the data sheets and later punched into IBM cards was the sum of the honor points following conversion from the grading system. Decimals of the summed honor points were rounded off to the next highest number, i.e. 15.5 became 16. Mathematics courses repeated by a student were not common, but where this had occurred honor points were based on the more recent experience.

A large majority of public schools in Washington State used the A, B, C, D, and F system of grading. A number of Oregon State public schools have changed from an inverted number system of "1" for high and "5" for low to the letter grade system. Hence it was not uncommon to have two separate grading systems represented on one high school transcript. The use of per cent was not widespread.

The fifth predictor variable, number of semesters of high school

TABLE 3

CONVERSION OF HIGH SCHOOL GRADES
TO HONOR POINTS

PER CENT	INVERTED NUMBERS	LETTER	HONOR POINT VALUE
93-100	1	A	4.0
89- 92	1- or 2+	A- or B+	3.5
85- 88	2	B	3.0
82- 84	2- or 3+	B- or C+	2.5
78- 81	3	C	2.0
74- 77	3- or 4+	C- or D+	1.5
70- 73	4	D	1.0
65- 69	4-	D-	0.5
64- below	5	F	0.0

solids, was a count of each student's number of semesters of experience in specified high school courses. The courses included were presented in Chapter I. From the high school transcript a count was made of the courses specified where the course had been completed with a passing grade. The data then was recorded on the data sheets and punched directly into IBM cards without coding.

The sixth predictor variable, high school honor points earned in shop courses, required a check of the high school transcript and a conversion of shop grades into honor points in the same fashion as that used for mathematics. Courses included those where shop practices or trade skills appeared to be the principle content and vocational-agriculture courses where it was clear the course dealt with skills allied to the trades and not to animal husbandry. The sum of honor-points was recorded on the data sheets and punched directly into IBM cards without coding.

Data was collected on the regression analysis sample during 1961-1963. Data on the validation sample was collected during 1963-1964.

V. DATA HANDLING

All data punched into IBM cards was verified. Simple calculations of the data were programmed for a 1620 computer at Clark College. The program was made by an advanced IBM technician student under the supervision of the data processing program instructor. These calculations were sums of variables, counts of cases for each sample, sums of squares, sums of cross products.

The "print out" to verify information punched was used to

cross-check certain of the sums, squares and sums of squares, and cross products. The "print out" of the data on the validation sample was used as a work sheet for recording predictions made by calculator on the basis of regression equations developed by this study. (A sample of this process is presented as Table 17, Appendix B) Thus direct comparison of each earned first quarter GPA and the predicted first quarter GPA made in this study could be seen.

All statistical work beyond these simple calculations was done by hand on a Friedan desk type calculator. These procedures followed the outline for statistical methods set forth in Chapter I and presented in detail in Chapter IV.

CHAPTER IV

PRESENTATION AND INTERPRETATION OF DATA AND RESULTS

The six sections of this chapter begin with the calculation and presentation of variable inter-correlations and proceed to the validation study of the predictions made from the regression equations developed. Interpretation of results is made in each section.

As defined in Chapter I, the criterion variables were:

Y_1 = GPA earned by math-science-engineering majors

Y_2 = GPA earned by social science-humanities majors

Y_3 = GPA earned by undecided liberal arts majors

Y_4 = GPA earned by applied arts majors

Y_5 = GPA earned by business-secretarial science majors

These variables will be referred to by "Y" and the appropriate sub-number in the text.

The predictor variables were defined in Chapter I as:

X_1 = All-college prediction for GPA as received from the Washington Pre-College Testing Program (See Appendix A, Figure 1)

X_2 = Number of quarter hours registered for the first quarter of study

X_3 = Residence

X_4 = Honor points in high school mathematics

X_5 = Semesters of solids in high school

X_6 = Honor points in shop courses in high school

I. INTERCORRELATIONS

Table 4 shows the intercorrelations between the six predictor variables used with each of the five criterion variables. These one hundred zero-order correlations were calculated by using the Air Force Method derived from the standard method of calculating Pearson Product-Moment correlations coefficients by the deviation formula:

$$r_{xy} = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \quad \Sigma y^2}}$$

Tuman gave a step-by-step set of instructions for using this method. (29:29-34)

In the case of each criterion, the highest validity coefficient for predictors was that for variable X_1, all-college prediction. However, these correlations of X_1 with each of the criterion variables are no better than could be expected from a good fifty minute English test.

The following improvement in forecasting by using only the all-college prediction would result:

Criterion	r with X_1	Better than Chance Forecasting Efficiency (%)
Y_1	.468	12 per cent
Y_2	.635	25 per cent
Y_3	.549	16 per cent
Y_4	.241	3 per cent
Y_5	.505	14 per cent

"r" is the coefficient of forecasting efficiency for X_1, and the per cent given for "E" is interpreted as that much better than chance and means that the error is the per cent improvement over a standard error equal

TABLE 4

FIVE INTERCORRELATION MATRICES FOR SIX PREDICTOR VARIABLES WITH FIVE CRITERIA

	X_1	X_2	X_3	X_4	X_5	X_6	Y
(1) math-science-engineering							
X_1	1.00	.47	.30	.64	.55	.09	.47
X_2		1.00	.13	.39	.37	-.04	.25
X_3			1.00	.25	.28	.09	.10
X_4				1.00	.73	.13	.41
X_5					1.00	.04	.34
X_6						1.00	.03
(2) social science-humanities							
X_1	1.00	.41	.46	.45	.25	-.26	.66
X_2		1.00	.21	.25	.35	-.09	-.20
X_3			1.00	.19	.30	-.11	.21
X_4				1.00	.59	.04	.34
X_5					1.00	-.10	.23
X_6						1.00	-.15
(3) undecided							
X_1	1.00	.26	.36	.39	.42	-.19	.55
X_2		1.00	.19	.17	.25	.002	.06
X_3			1.00	.12	.26	.02	.12
X_4				1.00	.63	.17	.38
X_5					1.00	.01	.23
X_6						1.00	-.14
(4) applied arts							
X_1	1.00	.01	.09	.43	.46	.04	.24
X_2		1.00	.11	.06	.05	-.12	-.19
X_3			1.00	-.03	.13	.20	-.09
X_4				1.00	.57	.10	.19
X_5					1.00	-.01	.02
X_6						1.00	.004
(5) business-secretarial science							
X_1	1.00	.19	.51	.31	.47	-.17	.51
X_2		1.00	.40	.06	.03	.07	.13
X_3			1.00	.11	.26	-.11	.13
X_4				1.00	.55	.03	.22
X_5					1.00	-.001	.19
X_6						1.00	-.13

Where:

X_1 = all-college prediction
X_2 = hours completed first quarter
X_3 = residence
X_4 = math honor points
X_5 = semesters of solfa
X_6 = shop honor points

to the standard deviation of the criterion. This is developed from the formula, $E = 1 - \sqrt{1 - r^2}$. (2:173)

It is evident the prediction for GPA in applied arts (Y_4) would be extremely low in efficiency when the all-college prediction is used alone.

II. MEANS AND STANDARD DEVIATIONS

Table 5 presents the means and standard deviations for the predictor and criterion variables. This data shows the need for categorizing the total sample studied. The samples for each criterion show substantial differences of characteristics as measured by the variables selected as predictors. For example, Y_1 (math-science-engineering) and Y_4 (applied arts) have different characteristics as measured by mean values of predictors from high school experiences and background, residence and the predicted performance by the all-college prediction. Regarding X_4 (math honor points earned in high school), the means are 14.52 and 6.38 with the difference favoring Y_1 (math-science-engineering). For X_5 (residence), the means are .32 to .59 where 1 equals resident and where the difference favors Y_4 (applied arts), there being more non-residents in the applied arts sample.

Notwithstanding the difference in characteristics of math-science-engineering majors and applied arts majors, the two samples show little difference in mean earned first quarter GPA (Y_1 and Y_4), 2.10 to 2.13 favoring the applied arts majors. Thus, in spite of the differences demonstrated in pre-college characteristics by these two samples, they achieved nearly equally well because of factors unique to their areas

TABLE 5

MEANS AND STANDARD DEVIATIONS FOR
SIX PREDICTOR VARIABLES *
AND FIVE CRITERIA **

	X_1	X_2	X_3	X_4	X_5	X_6	Y
$\bar{X}^a$ N = 243	1.99	16.30	.83	14.52	19.25	7.57	2.10
SD[b]	.49	1.56	.38	7.57	5.06	8.55	.69
$\bar{X}$ N = 267	1.96	16.34	.72	9.80	15.20	3.12	2.15
SD	.53	2.02	.45	5.24	4.53	6.05	.83
$\bar{X}$ N = 348	1.79	15.42	.68	10.92	15.41	6.43	2.00
SD	.52	3.04	.47	6.31	5.16	7.83	.75
$\bar{X}$ N = 171	1.40	15.78	.59	8.88	12.43	14.67	2.14
SD	.34	2.36	.49	5.15	4.64	9.75	.74
$\bar{X}$ N = 179	1.76	16.07	.52	9.30	14.06	4.96	1.93
SD	.46	1.03	.49	5.03	4.51	7.67	.73

[a] $\bar{X}$ = mean

[b] SD = standard deviation

*where:
- X_1 = all-college prediction
- X_2 = hours completed first quarter
- X_3 = residence
- X_4 = math honor points
- X_5 = semesters of college
- X_6 = shop honor points

**where:
- Y_1 = math-science-engineering
- Y_2 = social science-humanities
- Y_3 = undecided
- Y_4 = applied arts
- Y_5 = business-secretarial science

of study.

The above indicates the inadequacy of the all-college prediction for predicting success in all programs without differentiation at Clark College. There was little difference in mean earned GPA (Y) for any of the five samples, ranging from 2.15 to 1.93. However, the all-college prediction (X_1) ranged from 1.99 to 1.40.

III. PREDICTORS SELECTED

Each matrix of Table 4 was used as a worksheet for iterating to select a maximum prediction battery for each criterion. The approach used was developed by Horst and Smith. (15:277-282)

The predictors selected and their order of selection are presented in Table 6. In all cases, X_1 (all-college prediction) was selected first. X_6 (high school shop honor points) was never picked up as a valuable predictor, not even for applied arts majors. This finding suggests that the junior college counselor should not be influenced by the program in industrial arts taken in high school.

For criterion Y_1 only X_4 (high school math honor points) added regression variance to X_1 (all-college prediction). For the other four criteria, Y_3 had four predictors and Y_2, Y_4, and Y_5 had five predictors contributing regression variance.

IV. MULTICORRELATIONS AND STANDARD ERRORS OF ESTIMATE

Table 7 lists the multicorrelation coefficients and the standard errors of estimate (SE) for each criterion. In all cases, the multi-correlation coefficient was corrected with Snedecor's shrinkage formula

TABLE 6

PREDICTORS SELECTED FOR EACH CRITERION AND IN ORDER SELECTED

Criterion	X_1	X_2	X_3	X_4	X_5	X_6
Y_1	1			2		
Y_2	1	4	3		2	
Y_3	1	3	2	4		
Y_4	1	2	3	4	5	
Y_5	1	3	2	4	5	

where:

Y_1 = math-science-engineering
Y_2 = social science-humanities
Y_3 = undecided liberal arts
Y_4 = applied arts
Y_5 = business-secretarial science

X_1 = all-college prediction
X_2 = hours completed
X_3 = residence
X_4 = math honor points
X_5 = semesters of solids
X_6 = shop honor points

TABLE 7

MULTI-CORRELATIONS AND STANDARD ERRORS OF ESTIMATES*

Criterion	R^2	R_c^2	R_c	SD_Y	SE_Y	SE_{ACP}**
Y_1	.240	.234	.494	.691	.605	.573
Y_2	.476	.468	.717	.831	.605	.573
Y_3	.317	.309	.556	.751	.624	.573
Y_4	.137	.111	.333	.738	.696	.573
Y_5	.300	.290	.529	.730	.619	.573

*Where:

Y_1 = math, science, engineering
Y_2 = social science-humanities
Y_3 = undecided
Y_4 = applied arts
Y_5 = business-secretarial science

and where:

$R^2 = \Sigma(r_{X \cdot Y})(B_{X \cdot Y})$

$R_c^2 = \frac{(N-1)(R^2) - (m-1)}{N-m}$ (Snedecor's shrinkage formula)

$R_c = \sqrt{R_c^2}$

$SE_Y = SD\sqrt{1-R_c^2}$

**SE_{ACP} = standard error of estimate all-college prediction (22)

to reduce the overestimate resulting in the design. The largest multicorrelation coefficient was .717 for Y_2 (social science-humanities), and the smallest was .333 for Y_4 (applied arts).

What improvement has resulted in predictive efficiency in developing the maximum prediction battery? In comparing the validity coefficients of X_1 (all-college prediction) with the corrected multicorrelations, the following changes resulted in E, the coefficient of forecasting efficiency:

Criterion	r with X_1	E_1	R_c	E_2
Y_1	.463	12%	.434	13%
Y_2	.655	25%	.717	31%
Y_3	.549	18%	.556	17%
Y_4	.241	3%	.333	6%
Y_5	.505	14%	.529	15%

This is where "r with X_1" is the zero-order correlation of X_1 and the respective criterion. "E_1" is the coefficient of forecasting efficiency for X_1 alone. "R_c" is the corrected multicorrelation coefficient between the predictors indicated on Table 6 and the respective criterion. "E_2" is the coefficient of forecasting efficiency for R_c. The per cent given for E is interpreted as that much better than chance and means that the error is the per cent improvement over a standard error equal to the standard deviation of the criterion.

Table 7 shows that the standard error of prediction ranged from .696 to .605. This means that 68 per cent of the predicted GPAs should fall within one standard error, and about 95 per cent should fall within

two standard errors of the actual earned GPA. In a random guess, the standard error would be equal to chance, that is, equal to the standard deviation of the criterion. Thus, in comparing columns four and five in Table 7, a considerable improvement is indicated from the design.

The last column of Table 7 gives the SE (standard error of estimate) of the all-college prediction, taken from Blumenthal's study. (22) The underestimate of this value is explained in section VI: Validation.

IV. CONTRIBUTION OF REGRESSION VARIANCE BY PREDICTORS

The contribution of regression variance by each predictor variable is shown in Table 8. As would be expected from the data on intercorrelations in Table 4, the largest contribution of any one variable to a particular criterion was made by X_1 (all-college prediction).

The last column of Table 3, R^2 (multicorrelation coefficient) is interpreted as per cent predicted. For example in the case of Y_1, the regression variance predicted is twenty-four per cent, leaving seventy-six per cent unpredicted (that is, some other factors determine these residuals). (3:232)

V. REGRESSION EQUATIONS

Beta-weights and regression coefficients were calculated by the Abbreviated Doolittle Method. (3:390-392)

Five regression equations were calculated, one for each criterion, and are shown in Table 9. The regression equations were used to predict first quarter GPA for the validation samples. An example of this process

TABLE 3

CONTRIBUTION OF REGRESSION VARIANCE
BY EACH PREDICTOR

	Predictor variables	Sign	r	B	Contributions	R^2
For Y_1	X_1	+	.463	.346	.1603	
	X_4	+	.410	.183	.0773	
					Σ = .2403	.2400
For Y_2	X_1	+	.655	.735	.3347	
	X_3	+	.240	.192	.0431	
	X_5	-	.214	-.152	.0259	
	X_2	-	.195	-.142	.0220	
					Σ = .4757	.4757
For Y_3	X_1	+	.540	.575	.2087	
	X_3	-	.117	-.081	.0086	
	X_5	-	.064	-.041	.0047	
	X_4	+	.261	.261	.0146	
					Σ = .3166	.3166
For Y_4	X_1	+	.241	.244	.0555	
	X_2	+	-.137	-.204	.0361	
	X_3	+	-.094	-.110	.0093	
	X_4	+	.188	.179	.0320	
	X_5	-	.023	-.169	.0035	
					Σ = .1370	.1370
For Y_5	X_1	+	.505	.516	.1449	
	X_3	-	.133	-.107	.1215	
	X_2	+	.126	.092	.0094	
	X_4	+	.220	.147	.0150	
	X_5	-	.186	-.156	.0134	
					Σ = .3032	.3032

Where:

Y_1 = math, science, engineering
Y_2 = social science, humanities
Y_3 = undecided
Y_4 = applied arts
Y_5 = business, secretarial science

X_1 = All-university Prediction
X_2 = hours first quarter
X_3 = residence
X_4 = math honor points
X_5 = semesters of solids

*and: Contribution = $\frac{(r \cdot B)(R^2)}{\Sigma (r \cdot B)}$

TABLE 9

REGRESSION EQUATIONS

$Y_1 = 4.924\ X_1 + 1.740\ X_4 + 87.304$

$Y_2 = 11.486\ X_1 + 3.525\ X_5 - 20.155\ X_3 - 5.110\ X_2 + 5.759$

$Y_3 = 4.217\ X_1 + 12.043\ X_3 - 1.993\ X_2 + 0.724\ X_4 + 83.469$

$Y_4 = 5.341\ X_1 - 6.364\ X_2 - 16.532\ X_3 + 2.570\ X_4 - 2.657\ X_5 + 259.922$

$Y_5 = 9.701\ X_1 - 29.227\ X_3 + 3.662\ X_2 + 2.110\ X_4 - 2.515\ X_5 + 0.345$

Where:

Y_1 = math-science-engineering majors
Y_2 = social science-humanities majors
Y_3 = undecided majors
Y_4 = applied arts majors
Y_5 = business-secretarial science majors

X_1 = all-college prediction
X_2 = hours completed first quarter
X_3 = residence
X_4 = math honor points
X_5 = semesters of solids
X_6 = shop honor points

appears as Table 17, Appendix B.

VI. VALIDATION

The selection of samples for the validation study was presented in Chapter III. These samples were drawn from the entire entering freshman class of 1963-64 at Clark College. They were categorized in an identical fashion with those of the study samples.

The data on the validation samples were punched into IBM cards. Predictions for each student were then calculated by using the regression equations presented in Table 9. These were entered directly on the "print out" sheets made by reproducing the recorded data. (See Table 17, Appendix A) These predictions were then compared in efficiency with the all-college prediction by determining the accuracy of forecasting earned GPA for the individual cases in each of the several examples. The results of this tabulation are presented as Tables 10, 11, 12, 13 and 14.

From Table 10, the regression equation for Y_1 (math-science-engineering) gave predictions that were within the expected limits of SE. For instance, of the 134 cases in the validation sample, twenty-six were expected to fall within plus of minus .25 SE. In actuality twenty-five cases resulted. However the all-college prediction underestimated the SE as only twenty-one cases fell within plus and minus .25 SE. As this is the case for all five criteria, not only does the all-college prediction underestimate the actual GPA (see Table 2), the standard error of estimate is incorrect as well, being larger than reported.

From Table 11, the regression equation for Y_2 (social science-

TABLE 10

A COMPARISON OF EXPECTED AND ACHIEVED GPA FOR CRITERION 1 IN TERMS OF STANDARD ERRORS OF ESTIMATE FOR THE REGRESSION EQUATION AND FOR THE ALL-COLLEGE PREDICTION VALIDATION SAMPLE A

SE** Units	Cum % Expected	Cum N Expected	Cum N[a] Regression Equation	Cum N[b] All-college Prediction
.25	19.7	26	25	21
.50	38.3	51	46	44
.75	54.7	73	70	64
1.00	68.3	92	83	77
1.25	78.9	106	93	93
1.50	86.6	116	110	103
1.75	92.0	123	118	113
2.00	95.4	128	124	120
2.05	(4.5)	134	134	134

Where: SE estimate all-college prediction = .573
SE estimate regression equation Y_1 = .605

**This colum indicates the range of expected forecasts. For instance .25 SE means that group with a prediction within plus and minus .25 standard error. In the case of Y_1 regression equation, this would be .00 to ± .15 GPA points between actual and predicted GPA.

a. cumulative N resulting from actual GPA minus predicted GPA from regression equation.

b. cumulative N resulting from actual GPA minus predicted GPA of all-college prediction.

TABLE II

A COMPARISON OF EXPECTED AND ACHIEVED GPA FOR CRITERION 2 IN TERMS OF STANDARD ERRORS OF ESTIMATE FOR THE REGRESSION EQUATION AND FOR THE ALL-COLLEGE PREDICTION VALIDATION SAMPLE *

SE** Units	Cum % Expected	Cum # Expected	Cum #[a] Regression Equation	Cum #[b] All-college Prediction
.25	19.7	27	36	19
.50	38.3	53	68	43
.75	54.7	75	90	63
1.00	68.3	94	113	93
1.25	78.9	109	124	110
1.50	86.6	120	131	120
1.75	92.0	127	133	125
2.00	95.4	132	136	131
over 2.00	(4.5)	133	138	133

*Where: SE estimate all-college prediction = .573
SE estimate regression equation Y_2 = .730

**This column indicates the range of expected forecasts. For instance .25 SE means that group with a prediction within plus and minus .25 standard error. In the case of Y_2 regression equation, this would be .00 to ± 13 GPA points between actual and predicted GPA.

a. cumulative N resulting from actual GPA minus predicted GPA from regression equation.

b. cumulative N resulting from actual GPA minus predicted GPA of all-college prediction.

humanities) gave predictions that were better than the expected limits of SE. For the 133 cases in the validation sample, twenty-seven were expected to fall within plus or minus .25 SE. In actuality thirty-six cases resulted. The all-college prediction had but nineteen cases within plus or minus .25 SE. Thus the regression equation for Y_2 was more efficient than would be expected, and the all-college seriously underestimated the SE and was much less efficient than would be expected.

From Table 12, the regression equation for Y_3 (undecided liberal arts) gave predictions that were close to those expected and better than expected within plus or minus 1.00 SE. For the 131 cases in the validation sample, twenty-six were expected to fall within plus or minus .25 SE. In actuality twenty-three cases resulted. The all-college prediction had but sixteen cases within plus or minus .25 SE. Though the regression equation for Y_3 was slightly less efficient than expected (though at ±1.00 it is more efficient), it was much more efficient than the all-college prediction which again seriously underestimated the SE and was less efficient.

From Table 13, the regression equation for Y_4 (applied arts) gave predictions better than expected within limits of SE. For the eighty-two cases in the validation samples, sixteen were expected to fall within plus or minus .25 SE. In actuality twenty-one cases resulted. The all-college prediction had but eight cases within plus or minus .25 SE. Thus the regression equation for Y_4 was a considerable improvement in efficiency of forecasting over the all-college prediction. It should be noted that the all-college prediction produced errors larger than 2.00 SE for thirty-three of eighty-two cases. This evidence conclusively

TABLE 12

A COMPARISON OF EXPECTED AND ACHIEVED GPA FOR CRITERION Y IN TERMS OF STANDARD ERRORS OF ESTIMATE FOR THE REGRESSION EQUATION AND FOR THE ALL-COLLEGE PREDICTION VALIDATION SAMPLE *

SE** Units	Cum % Expected	Cum N Expected	Cum N[a] Regression Equation	Cum N[b] All-college Prediction
.25	19.7	26	23	16
.50	33.3	50	44	33
.75	54.7	72	68	60
1.00	68.3	89	94	80
1.25	78.9	103	107	91
1.50	86.6	113	119	106
1.75	92.0	121	127	116
2.00	95.4	125	129	123
over 2.00	(4.5)	131	131	131

*where: SE estimate all-college prediction = .573
SE estimate regression equation Y_3 = .624

**This colum indicates the range of expected forecasts. For instance .25 SE means that group with a prediction within plus and minus .25 standard error. In the case of Y_3 regression equation, this would be .00 to ±.16 GPA points between actual and predicted GPA

a. cumulative N resulting from actual GPA minus predicted GPA from regression equation.

b. cumulative N resulting from actual GPA minus predicted GPA of all-college prediction.

TABLE 13

A COMPARISON OF EXPECTED AND ACHIEVED GPA FOR CRITERION 4 IN TERMS OF STANDARD ERRORS OF ESTIMATE FOR THE REGRESSION EQUATION AND FOR THE ALL-COLLEGE PREDICTION VALIDATION SAMPLE *

SE** Units	Cum % Expected	Cum N Expected	Cum N[a] Regression Equation	Cum N[b] All-college Prediction
.25	19.7	16	21	3
.50	38.3	31	35	13
.75	54.7	45	43	18
1.00	68.3	56	57	24
1.25	78.9	65	64	31
1.50	86.6	71	69	36
1.75	92.0	75	77	44
2.00	95.4	78	80	49
over 2.00	(4.5)	82	82	82

*where: SE estimate all-college prediction = .570
SE estimate regression equation Y_4 = .636

**This colum indicates the range of expected forecasts. For instance .25 SE means that group with a prediction within plus and minus .25 standard error. In the case of Y_4 regression equation, this would be .00 to ±.17 GPA points between actual and predicted GPA.

a. cumulative N resulting from actual GPA minus predicted GPA from regression equation.

b. cumulative N resulting from actual GPA minus predicted GPA of all-college prediction.

demonstrates that the all-college prediction by itself is of no value in forecasting GPA for Y_4 (applied arts). On the other hand it can be seen from Table 13 that the regression equation for Y_4 produced results better than would be expected within limits of the SE.

From Table 14, the regression equation for Y_5 (business-secretarial science) gave predictions less accurately than expected within limits of SE. When compared with predictions from the all-college prediction, however, it can be seen that those of Y_5 are more efficient. For example for the eighty cases in the validation sample, sixteen were expected to fall within plus or minus .25 SE. In actuality twelve cases resulted from the regression equation and but ten from the all-college predictions. There would be four cases expected where errors larger than 2.00 SE resulted. For the regression equation, five cases of errors this large resulted. However for the all-college prediction, eleven cases of error larger than 2.00 SE resulted. Though the regression equation represented an improvement over the all-college prediction and should be used in preference to the all-college prediction, the efficiency of prediction is lower than expected.

For all criterion samples, the predictions from the regression equations presented in Table 9 were an improvement over those made on the basis of the all-college prediction.

Mean differences were used in the pilot study as a convenient check of group performance against achievement and served to question the efficiency of the all-college prediction and to call attention to the need for further study. A validation of regression analysis is necessarily explained in terms of standard errors of estimate as has

TABLE 14

A COMPARISON OF EXPECTED AND ACHIEVED GPA FOR CRITERION 5 IN TERMS OF STANDARD ERRORS OF ESTIMATE FOR THE REGRESSION EQUATION AND FOR THE ALL-COLLEGE PREDICTION VALIDATION SAMPLE *

SE** Units	Cum % Expected	Cum N Expected	Cum N[a] Regression Equation	Cum N[b] All-college Prediction
.25	19.7	16	12	10
.50	38.3	31	20	21
.75	54.7	44	33	29
1.00	68.3	55	46	39
1.25	78.9	62	55	50
1.50	86.6	69	66	60
1.75	92.0	74	70	65
2.00	95.4	76	75	69
over 2.00	(4.5)	80	80	80

*Where: SE estimate all-college prediction = .578
SE estimate regression equation Y_5 = .619

**This column indicates the range of expected forecasts. For instance .25 SE means that group with a prediction within plus and minus .25 standard error. In the case of Y_5 regression equation, this would be .00 to ±.15 GPA points between actual and predicted GPA.

preceded. However it is of interest to note that the wide differences between mean predicted GPA and mean earned first quarter GPA found when the all-college prediction was used alone were found to be improved upon by using the regression equations developed; that is to say the differences between prediction and achieved were lessened.

Table 15 gives the differences between the mean predicted first quarter GPA and the earned first quarter GPA for each of the criterion samples in the validation study.

Table 16 gives a comparison of the differences between predicted and earned GPA when these differences are taken from Table 2, Chapter III, and from Table 15. The regression equations produced mean errors of prediction smaller than the all-college prediction. This is true in all instances. However the improvement of prediction for criterion Y_5 (business-secretarial) is small.

Table 14 indicated the error for individual case prediction for Y_5 exceeded the error expected in terms of the standard error of estimate for the regression equation. Table 16 indicates this error is also true for the group as a mean error of prediction of .306 was found. A sampling error for either the study sample or validation sample for Y_5 (business-secretarial science) is evident. It is likely the error is with the validation sample which has but eighty cases. Further work with criterion variable five is needed.

TABLE 15

MEAN DIFFERENCES EARNED AND PREDICTED GPA
PREDICTIONS FROM REGRESSION EQUATIONS
VALIDATION SAMPLE

Criterion	Mean Earned GPA	Mean Predicted GPA	N
Y_1	2.132	2.083	134
Y_2	2.197	2.207	139
Y_3	2.142	2.025	131
Y_4	2.346	2.192	82
Y_5	2.213	1.907	80

Where: N = number of cases in each sample

Y_1= math, science, engineering

Y_2= social science, humanities

Y_3= undecided

Y_4= applied arts

Y_5= business, secretarial science

TABLE 16

COMPARISON OF DIFFERENCES BETWEEN MEAN PREDICTED AND EARNED GPA USING ALL-COLLEGE PREDICTIONS AND REGRESSION EQUATIONS DEVELOPED

Criterion	Mean Difference Predicted Achieved (From Table 2) All-University	Mean Difference Predicted Achieved (From Table 15) Equations	Decrease in Mean Error
Y_1	0.165	0.044	0.121
Y_2	0.229	0.010	0.219
Y_3	0.316	0.117	0.199
Y_4	0.881	0.154	0.727
Y_5	0.402	0.306	0.096

Where: Y_1 = math, science, engineering

Y_2 = social science, humanities

Y_3 = undecided

Y_4 = applied arts

Y_5 = business, secretarial science

CHAPTER V

SUMMARY

I. THE PROBLEM

The problem in this study was to determine if it was possible to improve on the efficiency of predicting first quarter GPA for entering freshmen at Clark College, Vancouver, Washington. The prediction program used at Clark College was the Washington Pre-College Testing Program. In practice this prediction program centered on the all-college prediction. A pilot study had revealed that this prediction was inefficient in the forecasting of first quarter GPA. It was hypothesized that the prediction of success at Clark College for the first quarter of college work could be improved by using five selected variables in conjunction with the Washington all-college prediction. (The survey of pertinent literature revealed the present study to be unique. Very little has been done in predicting success in the junior college. The Washington Pre-College Testing Program had no research on performance at the junior college level.)

II. METHOD

Samples selected for study were: (1) the pilot study sample of 616 first experience freshmen entering Clark College in the Fall of 1961; (2) the study sample made up of the pilot study sample plus the first experience freshmen entering Clark College in the Fall of 1962, for a

total of 1,213 cases; and (3) the validation sample made up of the first experience freshman entering Clark College in the Fall of 1963, which included 565 cases.

The criterion variable was the earned first quarter GPA at Clark College. Grades at Clark College are on a five point scale, where A = 4, B = 3, C = 2, D = 1, and F = 0.

To achieve some homogeneity, the study sample and the validation sample were classified into five major areas of study relative to the Clark College curriculum and responding to the definitions of criterion variables, which (summarized) were:

Self-declared majors in

1. mathematics-science-engineering programs
2. social science-humanities programs
3. undecided but in lower division programs
4. applied arts programs
5. business-secretarial programs

Students were classifed into one or the other of these five criterion samples on the basis of their declaration of a major upon entering the college.

The variables selected for study in improving the forecasting efficiency for the prediction of first quarter success were:

1. all-college prediction for each student
2. Clark College credit hours completed the first quarter of study
3. residence
4. honor points earned in high school mathematics course work

5. sum of the semesters of solids of high school course work
6. honor points earned in high school shop course work

III. FINDINGS

Equations. A regression analysis was the design chosen to establish equations to be used in calculating predictions for first quarter GPA. Five equations were developed, one for each criterion variable:

1. mathematics-science-engineering

$$Y_1 = 4.924\ X_1 + 1.740\ X_4 + 37.304$$

2. social science-humanities

$$Y_2 = 11.466\ X_1 + 3.525\ X_5 + 28.155\ X_3 - 5.810\ X_2 + 51.759$$

3. undecided-lower division

$$Y_3 = 8.287\ X_1 - 12.983\ X_3 - 1.998\ X_2 + 0.724\ X_4 + 83.459$$

4. applied arts

$$Y_4 = 5.341\ X_1 - 5.384\ X_2 - 16.532\ X_3 + 2.570\ X_4 - 2.687\ X_5 + 259.922$$

5. business-secretarial science

$$Y_5 = 9.701\ X_1 - 29.227\ X_3 + 3.662\ X_2 + 2.110\ X_4 - 2.515\ X_5 + 0.845$$

Standard errors. The SE (standard error of estimate) for the equations were

$Y_1 = .605$

$Y_2 = .635$

$Y_3 = .624$

$Y_4 = .606$

$Y_5 = .610$

Validation. The predictions computed from the regression equations developed in this study were found: (1) to fall within the expected range of error for Y_1 (mathematics-science-engineering); (2) to be considerable improvements over expected error for Y_2 (social science-humanities) and Y_4 (applied arts); (3) to be slightly less efficient than expected error for Y_3 (undecided-lower division) below ±1.00 SE but an improvement over expected error at and beyond ±1.00 SE; and (4) to be low in efficiency for Y_5 (business-secretarial science).

Hypothesis. Validation of the regression equations showed the hypothesis postulated was achieved. The all-college prediction together with the selected variables improved the forecasts. Predictions computed from the regression equations for the validation samples produced more efficient predictions for first quarter GPA than those forecasted by the Washington all-college prediction.

The validation showed the error of prediction as measured by mean difference between predicted and achieved first quarter GPA was considerably lessened by use of the regression equations when compared with the mean error made by the all-college prediction. It was demonstrated also that the all-college prediction gave not only an underestimate of likely success at Clark College but the standard error of the all-college prediction was an underestimate as well.

IV. CONCLUSIONS

1. This study showed the danger of using predictions for college success developed in another institution. The problem is likely increased if the institutions are unlike in organization,

such as the experience at a four-year institution being applied to a junior college.

2. Prediction data should not be used until its validity is studied. As a state-wide design has been found wanting, this likely applies even to a greater extent to nation-wide formulas now being developed.

3. It appears that success in shop courses taken in high school does not indicate success in applied arts at the junior college.

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APPENDIX A

SAMPLE PREDICTION SHEET

SAMPLE OF THE TWO SIDES OF THE STUDENT'S COPY OF THE WASHINGTON PRE-COLLEGE TESTING PROGRAM DATA SHEET

SEE REVERSE SIDE

STUDENT'S COPY

10199999 NUMBER | UWWI SCHOOL | 64 YEAR | 1 (0 = MALE, 1 = FEMALE) SEX | 18 AGE | DOE LAST NAME | JO 1ST | JA 2ND

PREDICTOR DATA

AVERAGE HIGH SCHOOL GRADES

A ENGLISH	B MATH	C FOREIGN LANGUAGE	D SOCIAL SCIENCE	E NATURAL SCIENCE	F ELECTIVES
31	20	30	26	25	38

TEST SCORES

G VOCABULARY	H ENGLISH USAGE	I SPELLING	J READING SPEED	K READING COMP	L INTER MATH	M APPLIED MATH	N NUMER ABILITY	O QUANT REASONING	P SPATIAL ABILITY	Q MECHAN EX. PERCEP-TUS
39	56	23	21	12	04	06		46	15	05

ENGLISH DATA

1 VOCABULARY	2 USAGE	3 SPELLING	4	READING SPEED	READING COMP
62	60	58		43	53

STANDARD SCORES

SECTIONING DATA

		ENGLISH	INTER MATH
57	46	62	41

PREDICTED COLLEGE GRADES

1 ALL COLLEGE AVERAGE	2 ANTHROPOLOGY *	3 ARCHITECTURE	4 ART	5 BIOLOGY	6 BOTANY	7 BUSINESS ADMIN	8 CHEMISTRY	9 DRAMA	10 ECONOMICS	11 EDUCATION	12 ENGINEERING *	13 ENGLISH COMPOSITION	14 FAR EAST	15 ROMANCE LANGUAGES	16 FORESTRY *	17 GEOGRAPHY	18 GEOLOGY	19 HISTORY	20 HOME ECONOMICS **	21 JOURNALISM	22 MATH	23 MUSIC	24 NURSING **
25	24	29	27	21	25	24	20	33	23	28	77	27	29	26	77	21	22	26	27	31	21	32	28

25 PHARMACY	26 PHILOSOPHY	27 ***	28 PHYSICS	29 POLITICAL SCIENCE	30 PSYCHOLOGY	31 SOCIOLOGY	32 SPEECH	33 ZOOLOGY	34 ACCOUNTING	35 ASTRONOMY	36 CLASSICAL LANGUAGES	37 ENGLISH LITERATURE	38 ***	39 GERMANIC LANGUAGES	40 ATMOSPHERIC SCIENCES	41 MICROBIOLOGY	42 NUTRITION (HOME ECON) *	43 OCEANOGRAPHY	44 PUBLIC HEALTH	45 RADIO & TELEVISION	46	47	48
23	27	88	23	25	22	25	29	23	22	27	28	26	88	33	26	21	22	21	26	28			

* 77 IN NOS 12 AND 16 MEANS NO PREDICTED GRADE FOR WOMEN
** 77 IN NOS 20 24 AND 42 MEANS NO PREDICTED GRADE FOR MEN
*** 88 IN NOS 27 AND 38 MEANS NO PREDICTED GRADE FOR MEN OR WOMEN

DATA SHEET FOR 1963 REVISION

WASHINGTON PRE-COLLEGE TESTING PROGRAM DATA SHEET

* The all-college prediction which is read as 2.5 in this sample.

FIGURE 1

SAMPLE CLARK COLLEGE TRANSCRIPT

Name _____

Birthplace and Date Vancouver, Wash., June 19, 1945

Address _____ Vancouver, Wash.

HIGH SCHOOL

Fort Vancouver H.S.
Vancouver, Wash.

Grad. 63 Units 21
Class Rank 236/325
GPA 2.065

ADVANCED STANDING

DEGREES and CERTIFICATES

Date

Date

TRANSCRIPTS ISSUED TO:

DEPT	COURSE NUMBER	COURSE TITLE	CR	GR	HONOR POINTS
30784		FALL 63-64			
BUS	101	INTRO BUS	5	B	
GR A	011	PHOT + STRIP	5	A	
GR A	017	FINISH + BIND	2	A	
ENGL	081	WRIT FUNDS	2	C	
MATH	010	BASIC MATH	3	A	
		QTRLY GPA=3.47 TOTAL	17		
		ACCUM GPA=3.47	17		59
3-30784		WINTER 63-64			
GR A	012	PRESSWORK	6	C	
HLTH	101	PERS COMMUN	2	C	
ECON	022	INTRO ECONOMIC	3	D	
BUS	022	WORK TRNG LAB	1	A	
ENGL	082	WRITING FUND	2	C	
		QTRLY GPA=1.92 TOTAL	14		
		ACCUM GPA=2.77	31		86
3-30784		SPRING 63-64			
GR A	013	DESIGN COMP	6		
ENGL	083	WRITING FUND	2		
		QTRLY GPA=3.00 TOTAL	8		
		ACCUM GPA=2.82	39		110

FIGURE 2

SAMPLE CLARK COLLEGE REGISTRATION FORM

PRINT FIRMLY AND CAREFULLY

Student Code No.	**LOCATOR CARD - CLARK COLLEGE - Vancouver, Wa.**	Today's Date

(Circle one)
Su - F - W - Sp. 19....

College Term and Year | Name — Last | First | Middle | Age

Tel. No.

Permanent (Legal Address) No. Street | City | State

Tel.No.

Local Address No. Street | City | State

Parent's or Guardian's Name

Parent's or Guardian's Address

Tel. No. ————————

Person to Notify in Emergency

Name of Advisor

Undecided

College Major

~~First Time in this College~~
( ) Yes ( ) No

COURSE SCHEDULE

DEPARTMENT	Course No.	Sec.	Credit Hours	PERIOD M	T	W	TH	F	ROOM
TOTAL									

FIGURE 3

RIDGEFIELD HIGH SCHOOL, RIDGEFIELD, WASHINGTON
TRANSCRIPT OF CREDITS

Student Janet R. Doe — Student entered this school 8-31-'9 (Month Day Year)

Date of Birth July 9, 1943 (Month Day Year)

Place of Birth Olympia, Washington (City State)

Graduated _____ (Month Day Year)

Withdrew _____ (Month Day Year)

Marking System:
A 95 to 100
B 88 to 94
C 77 to 87
D 70 to 76
F 70 or below

Name	Test Data Date Given	Rating

Extra-Curricular Activities

Year 19 58 School Forks, Wash.

Subject	Sem. 1st	Marks 2nd	Credit
English	A	A	2
Fresh. Prob.	B		1
Algebra	A	A	2
Gen. Science	B	B	2
Health	A	A	1
P.E.	B	B	1
Wa h. History		B	1

Year 19 59 School Forks, Wash

Subject	Sem. 1st	Marks 2nd	Credit
English	A	A	2
Home Ec.	B	A	2
Typing	A	A	2
Biology	A	A	2
Chorus	B		1
Spanish	B	B	2

Year 19 60 School Ridgefield

Subject	Sem. 1st	Marks 2nd	Credit
Spanish (audit)	A	A	0
P.E.	A	A	1
English	A	A	2
Chemistry	A	A	2
Geometry	A	A	2
Sociology	A		1
Civics		A	1

Year 19 61 School Ridgefield

Subject	Sem. 1st	Marks 2nd	Credit
Spanish II	A	A	x2
English	A	A	x2
Sr. Soc. Studies	A	A	x2
Adv. Algebra	A	A	x2
U.S. History	A	A	x2

* Where: 1. high school mathematics honor points 24
2. semesters of high school solids 22
3. high school shop honor point 0

FIGURE 4

APPENDIX B

TABLE 17

SAMPLE "PRINT OUT" AND PREDICTION COMPUTATION WORKSHEET *

Student	Major	All-College Prediction[a]	Math Honor Points	First Quarter Predicted	GPA[b] Achieved
1.	1	9	2	135	106
2.	1	25	18	242	313
3.	1	22	25	239	198
4.	1	19	13	203	263
5.	1	17	5	180	016
6.	1	26	18	247	211
7.	1	19	12	202	276
8.	1	21	22	229	235
9.	1	17	17	201	272
10.	1	17	16	201	236

*For $Y_1 = 4.924\ X_1 + 1.714\ X_4 + 87.304$

a. All-college predictions should be read as two place figures with a decimal between; e.g. 2.5 is printed as 25.

b. Predicted and achieved GPA are three place figures with a decimal between the second and third figures; e.g. 1.06 is printed as 106.

VITA

DON ALVA MORGAN was born December 10, 1925, at Riverton, Utah, the son of Edgar Parks Morgan and Sarah (Crane) Morgan. He was educated in the public schools and graduated from Jordan High School in 1944. After graduation from the University of Utah, Salt Lake City, Utah, in 1949, with the degree of Bachelor of Arts, he took the Bachelor of Education, in 1951, and the Master of Arts, in 1952, degrees at Washington State University, Pullman, Washington.

His professional experience includes teaching, counseling, and administration in the public schools of Washington, Alaska, and Oregon. Prior to serving as Dean of Instruction at Clatsop College, Astoria, Oregon, for the year 1964-65, he was for four years an instructor-counselor at Clark College, Vancouver, Washington.

Other significant experience was four years service with the U.S. Foreign Service as Third Secretary in the Diplomatic Service and as a Vice Consul of Career. Duty assignments were to posts in India, Germany, and Washington, D. C.

Publications include several articles in the literature of counseling and guidance and a two volume book, Man and the Social Science, Clark College, 1964.